Cancer Imaging: Staging and Therapy Monitoring.

Positron Emission Tomography (PET)/Computerized Tomography (CT)

Homer A. Macapinlac, M.D.

18F-2-deoxy-D-glucose (FDG) is the most widely used PET tracer in clinical practice in the world and the majority is in oncologic applications. In the US, 1.74 million clinical FDG PET scans were performed in 2010 (95% for oncology). FDG PET/CT is currently used for both staging and restaging of many solid tumors. Most recently the US Centers for Medicare and Medicaid Services (CMS) has covered PET CT imaging for the initial and subsequent treatment strategy indication in most solid tumors. The National Comprehensive Cancer Network (NCCN) guidelines, has incorporated FDG PET/CT in many tumor types including thoracic tumors like NSCLC, SCLC, and in the evaluation of pulmonary nodules.

FDG PET/CT scans for diagnosis and staging of cancer in clinical practice are typically interpreted using “visual” interpretation which requires a great deal of clinical experience, knowledge of disease spread patterns for various tumors, and knowledge of normal variants and artifacts. Standardized image acquisition parameters are necessary for comparability of studies particularly in the restaging of patients with known malignancy. The best implementation of FDG PET in response evaluation is in the Revised Response Criteria for Malignant Lymphoma. Although visual interpretation is straightforward, quantitative methods are required for more robust comparative studies for response evaluation and monitoring studies. FDG PET is inherently a quantitative imaging technique and the measurement of treatment-induced changes is an attractive tool for assessing early response to therapy (before anatomic changes are seen). The standardized uptake value (SUV) is a widely used metric for assessing tissue accumulation of tracers defined as the ratio of radioactivity in tissue per milliliter (in mCi/mL) divided by the decay corrected activity injected to the patient (in mCi/Body Weight in gm). The body weight is the parameter most commonly used, but body surface area, SUL (lean body mass) etc. may also be employed. Standardization has been well summarized in guidelines set by the Society of Nuclear Medicine (SNM) and the European Association of Nuclear Medicine (EANM) for FDG PET/CT imaging in Oncology. This is a concerted effort to standardize imaging performance, including QA/QC procedures in an effort to allow improved consistency of imaging, interpretation, and more importantly allow improved quantification of response using SUV’s. The PET Response Criteria in Solid Tumors (PERCIST 1.0) was drafted by Wahl et.al. as a framework which may be useful for consideration in clinical trials or individual patients. The ability of imaging to provide indices to response such as tumor size, perfusion, and more recently FDG PET/CT imaging makes it a standard component of clinical practice and assessment of novel therapies. Multiple new tracers have been developed and have been used in limited clinical studies to interrogate other metabolic parameters. PET tracers for hypoxia (18F MISO, 64/60 Cu-ATSM) have been used to identify the tumor volume resistant to radiotherapy. Proliferation tracers like 18F-fluorothymidine (FLT) has been used for early response assessment in various tumors. At least 3 tracers have been used to target alpha V beta integrin expression to assess angiogenesis in solid tumors, potentially to identify appropriate patients for therapy and possible response evaluation. Androgen, estrogen, and EGFR receptor imaging agents have been developed to allow better patient selection and early response assessment with targeted therapy.